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DEVELOPMENT OF A NEW DESIGN CONCEPT (REPLACEABLE KNEE AND ELBOW PATCHES) FOR THE STANDARD ALUMINIZED PROXIMITYCOAT/TROUSER ENSEMBLE

NAVY CLOTHING AND TEXTILE RESEARCH FACILITY
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The Navy Clothing and Textile Research Facility (NCTRF) was tasked by the Air Force to develop and evaluate a removable knee and elbow patch design concept for aluminized proximity clothing. This new design concept should prove to be very effective in increasing the life cycle of the garment. When the elbows or knees of the coat and/or trousers begins to abrade or show evidence of deterioration, the firefighter simply replaces the defective patch.

This report contains information relating to design characteristics, compiled test data or user evaluation, and overall conclusions. NCTRF has recommended that this new design concept be considered for replaceable aluminized shell (coat and trousers) used on the new combination suit. The combination suit has been approved to replace the current standard aluminized proximity coat/trouser ensemble.

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INTRODUCTION:

During FY 88, the Air Force Engineering and Services Center (AFESC) tasked this Facility to further develop the new design concept of removable knee and elbow patches on the standard aluminized proximity coat/trouser ensemble.

Under this program, a phase I evaluation was initiated whereby a development quantity of the standard coat (Mil-C-29145) and trousers (Mil-T-29146) was manufactured with the sleeves and knees modified to accommodate the removable knee and elbow patches. This basic concept featured a pre-assembled three sided framework assembly, with a strip of hook fastener sewn to the inner underside edge of the frame to secure the applicable knee and elbow patch. The fire-fighters suits were fabricated of the new lightweight and flexible aluminized knit material.

In order to determine the overall acceptability of the new replaceable knee and elbow patches, a 90-day wear test evaluation of phase I garments was conducted at designated Navy and Air Force firefighting stations during the Jan-Mar 89 time frame. Based on compiled test data, it was concluded that the new design concept would minimize the need for the firefighter to replace their suits whenever flaking and/or delamination occurred in the respective knee and elbow areas. The firefighter would simply substitute a replaceable aluminized patch. However, it was determined that additional modifications to the design concept needed to be pursued. A major complaint was that the knee and elbow patch was detaching from the framework assembly. To compensate for the normal flexing action of the knee and elbow, the knee and elbow patches for phase II garments were made larger and with a "bellows pleat" positioned horizontally through the center of the patch.

This report encompasses information relating to our final phase II evaluation, and entails background information, the approach and procedures used to evaluate this new design concept, and conclusions derived from these results.

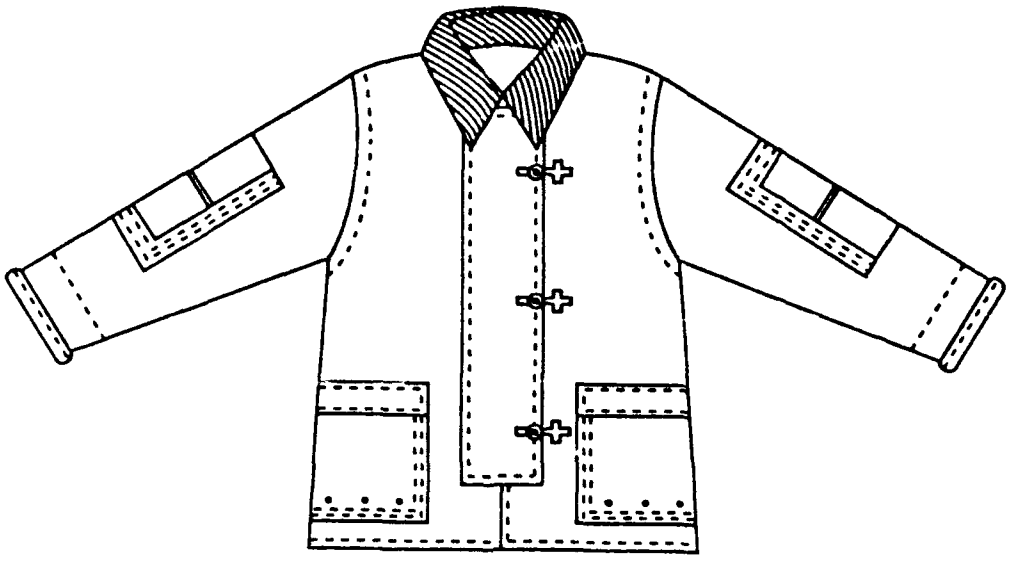
BACKGROUND:

During previous testing of experimental firefighters coats and trousers, this Facility found that a major complaint was excessive flaking and/or delamination occurring at such high stress areas as the elbows and knees of the respective garments.

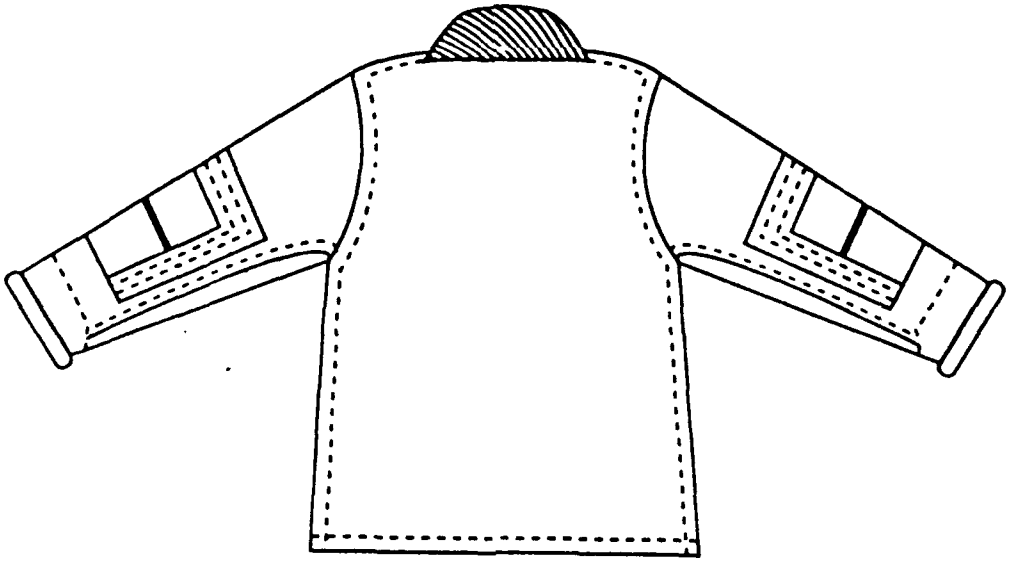
Accordingly, this Facility initiated a development program to design and evaluate a removable knee and elbow patch assembly for the aluminized proximity coat and trouser ensemble.

APPROACH:

The aluminized proximity coat as shown in Figure 1, was manufactured in strict accordance with Military Specification Mil-C-29145 except for the new and removable elbow patch concept added to each sleeve of the garment.



FRONT VIEW



BACK VIEW

FIGURE 1.
COAT, FIREMEN'S, ALUMINIZED PROXIMITY

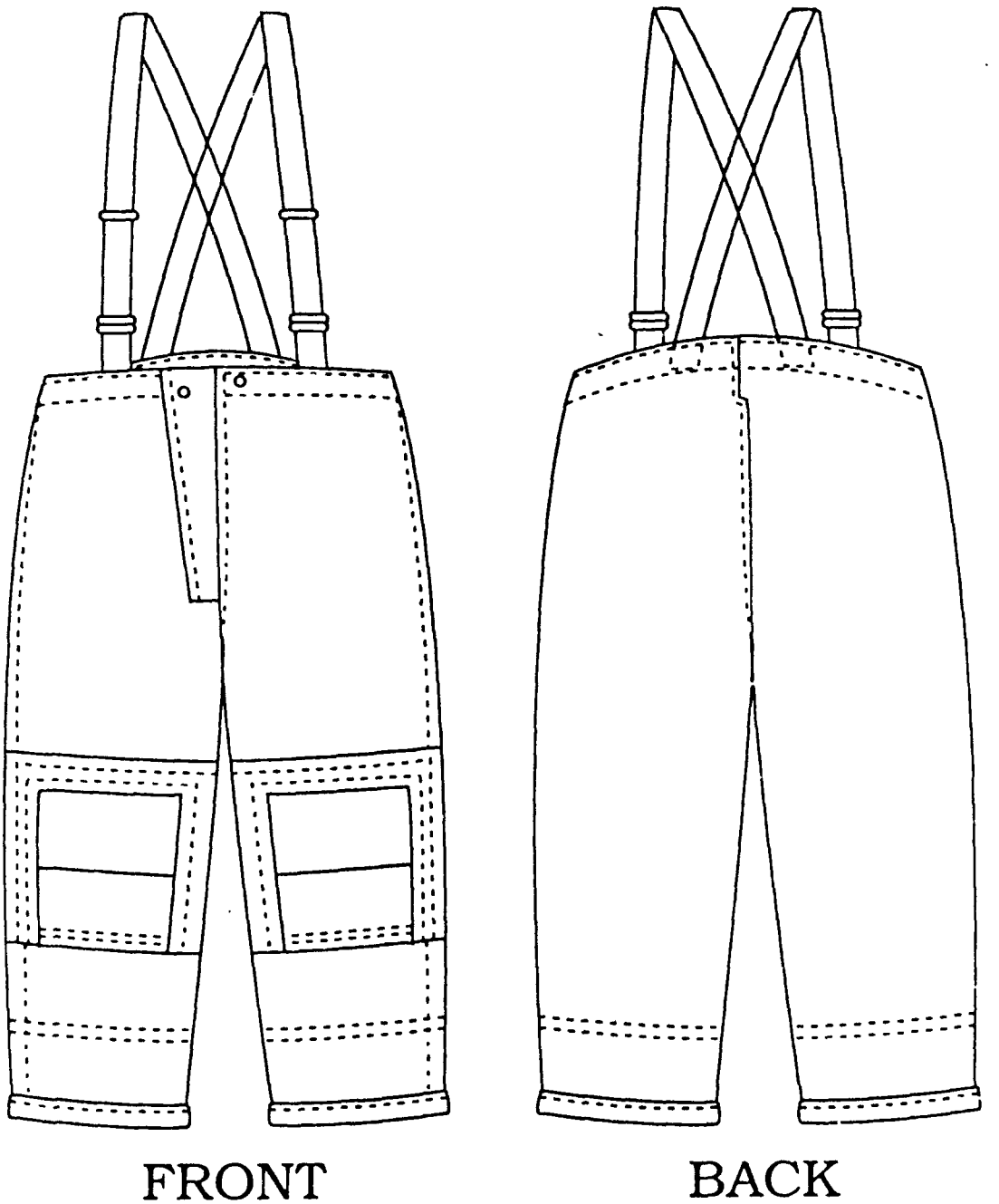


FIGURE 2.
TROUSERS, FIREMEN'S, ALUMINIZED PROXIMITY

The aluminized proximity trouser, as shown in Figure 2, was manufactured in strict accordance with Military Specification Mil-T-29146, except for the new and removable knee patch concept added to each knee of the garment.

PROCEDURE:

Twenty test participants selected from the following Navy, Air Force, and Marine Corps Air Stations, were each fitted with the aluminized proximity coat/trouser ensemble with the new replaceable knee and elbow patch in April 90 for a 90-day user evaluation:

Test Site	Location	Test Participants	Commenced
437 ABG/DEF	Charleston AFB, SC	5	28 Mar 90
1 CSG/DEF	Langley AFB, VA	5	28 Mar 90
Marine Corps Air Station	Beaufort, SC	5	28 Mar 90
Naval Auxiliary Landing Field	Chesapeake, VA	5	28 Mar 90

The test participants were requested to wear the aluminized proximity coat/trouser ensembles as often as possible throughout the wear test period.

Briefings were held with most of the test participants at each designated test site at the conclusion of the 90-day evaluation period.

In addition, two sets of the aluminized proximity coat/trouser ensembles were forwarded to Eglin AFB Firefighting School, Ft Walton Beach, FL in Aug 90. Our objective was to evaluate firefighters wearing the experimental garments under more severe training conditions for not more than 30 days after receipt of garments. Of particular importance, was to determine whether or not the knee and elbow patch remained intact during rigorous training exercises such as personnel crawling on their knees and elbows.

Questionnaire forms (Appendix A) were provided each test participant to develop information relative to such characteristics as number of times worn, acceptability of the new knee and elbow patch concept, favor of adoption, etc.

RESULTS:

Personal opinions concerning the suitability of this new design concept were the basis of the test questionnaire, with particular emphasis given to determining whether or not this new design concept would increase the overall serviceability of the garments.

Of the twenty test participants issued the aluminized proximity coat/trouser ensemble with the new removable knee/elbow patch concept, 14/22 (70%) responded to the test questionnaire.

Ten of twenty (50%) of the test participants responding were from Langley AFB and Charleston AFB. Each of the coat/trouser ensembles were worn over 60 days throughout the wear test period.

Four of twenty (20%) of the test participants responding were from Marine Corps Air Station, Beaufort, S.C. Each of the coat/trouser ensembles were worn 30-60 days throughout the wear test period.

Although questionnaire data were not received from the Naval Auxiliary Landing Field, personal contact with their divisional test monitor throughout the wear test period indicated a very positive response to this new design concept.

Serviceability: The majority of the responders (93%), felt that this new design concept will increase the overall serviceability of the garment.

Favor of Adoption: The majority of the responders (93%), favored adoption of this new design concept.

A summation of personal comments from the selected test participants are as follows:

Langley AFB and Charleston AFB

This concept seems to be workable and should increase the life of the bunkers. I am hopeful that this application will be cost effective.

This new design concept with the patches is very durable.

The patches have taken excessive wear over the test period. I feel that this concept will greatly increase the service life of the garment.

The removable knee and elbow patch appears to be a good idea because it will greatly increase the service life of the garment, i.e. when one patch wears out it can be simply replaced by another patch.

The removable patch idea is positive and an excellent feature.

The removable knee patches were helpful. I placed athletic pads inside of the patches and this has helped quite a bit during search and rescue operations.

Marine Corps Air Station, Beaufort, S.C.

The concept of removable knee and elbow patches received a favorable endorsement from all crash-rescue firefighters.

The additional padding offered in the knee patches was beneficial to the firefighter. It provided additional comfort and safety to the firefighters needs.

This new design concept should be evaluated in the dual ensemble outer shell.

It was felt that the new removable knee and elbow patches will greatly increase the serviceability of these items.

The knee pads served as a padding while kneeling.

Eglin AFB Firefighting School, Ft Walton Beach, FL

Weekly training exercises are conducted at Eglin AFB for Air Force firefighting personnel throughout the year. The two sets of aluminized proximity coat/trouser ensembles provided were evaluated by more than two test subjects. A total of six firefighters participated in this evaluation during the Aug-Sep 90 time frame. After each week of training, the two sets of aluminized proximity garments were passed on to the next class for evaluation.

Each of the coat/trouser ensembles were worn an average of 8-10 times per week during training exercises. At the conclusion of this user evaluation, all six firefighters favored adoption of the new design concept. It was also felt that this new design concept will increase the overall serviceability of the garments. A summation of their personal comments are as follows:

The elbows rarely wear out. The money would be better spent improving the groin area which wears out very quickly.

The knee patches need to dropped down approximately 2 inches.

If the knee/elbow patches should be damaged, they would be easy to repair.

The knee patches should be made thicker for added comfort.

They were good bunkers but maybe you could use something longer lasting than silver in the knees and elbows. Leather would be a great substitute.

Knee patches should be fabricated of a more durable material. Good idea.

Change the way the pads are connected to the bunkers (still use velcro), and it will be a very good idea.

The knee pads are a good idea but need to be longer in length.

DISCUSSION OF RESULTS:

User Evaluation: The majority of the test participants along with their divisional chiefs indicated that the new design concept of removable knee and elbow patches was an overwhelming success. Without exception, each of the removable knee and elbow patches remained intact within the respective frame assembly throughout the user evaluation. All of the selected fire-fighters were able to perform their many diversified duties without difficulty.

In regard to personal comments surfacing from this evaluation and as annotated in this report, it was felt that some of the suggestions received needed to be addressed before recommending adoption of this new design concept.

In that the new combination firefighters ensemble has been approved to replace the standard aluminized proximity coat/trouser ensemble, work was conducted in-house to demonstrate that the knee and elbow patches could be satisfactorily attached to the replaceable aluminized shell (coat and trousers) used on the new firefighters ensemble. The knee patches were relocated two inches below the former placement to improve their functionality.

Consideration was also given to the use of leather to achieve a more durable material for the replaceable knee and elbow patches. However, the National Fire Protection Association (NFPA) standards would not permit the use of this material on proximity protective garments. Leather will not reflect the high levels of radiant heat associated with aircraft rescue firefighting operations and with fires involving flammable liquids and gases.

Cost Data: Based on discussions held with current fabric and end item manufacturers of the aluminized coat/trouser covers. a projected estimated cost of materials and labor for constructing the knee and elbow frame assemblies along with the applicable replaceable patches will be $10 per garment. The materials required include the basic aluminized knit material and 100% FR "hook" and "pile" fastener tape. The cost of the current aluminized coat cover is $116.43 and the trouser covers $92.34 ($208.77 per ensemble). The cost of adding the patches is only 10 percent of the ensemble cost. Considering the additional wear life to be achieved, the use of a patch system would be very effective in reducing the life cycle cost of the garment.

CONCLUSIONS/RECOMMENDATIONS:

Military firefighters acceptance of this new and final design concept (replaceable knee and elbow patches), has substantiated our preliminary data of improved serviceability of the respective garments. When the elbows and/or knees of the coat and trousers begins to abrade or show evidence of deterioration, the firefighter simply replaces the defective patch. Replaceable knee and elbow patch designs for these garments are available for introduction into the supply system. It is the recommendation of this Facility that this new design concept be considered for the replaceable aluminized shell (coat and trousers) used on the new combination firefighters ensemble.

QUESTIONNAIRE

NAME AND RATE/GRADE: ----------

STATION: ----------

SIZE OF SUIT ISSUED: Medium -------- Large ----------

1. Number of times worn:

Up to 15 ------ 15 to 30 ------ 30 to 60 ------ Over 60 ------

2. Indicate how you liked the newly added features of removable knee and elbow patches.

Superior -------- Same -------- Worse -------- Not needed --------

If worse, please explain ----------

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3. Do you feel that this new design concept will increase the overall serviceability of the garment?

Yes ---------- No ----------

If No, please explain ----------

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4. Would you be in favor of the Military adopting this new concept for the standard issue crash-rescue suits?

Yes ------- No ------

If No, please explain ----------

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5. List any comment both positive and negative in regard to this new design concept of removable knee and elbow patches.
